FIJI SUGAR CORPORATION'S PROFITABILITY AND SUGAR CANE PRODUCTION: AN ECONOMETRIC INVESTIGATION, 1972-2000

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ABSTRACT

Sugar is Fiji’s oldest industry, being in the vanguard of economic growth and development for over a century. Since 1997, however, with the expiry of land leases and the impending erosion of the preferential European Union prices, the industry’s problems have compounded. While it is widely acknowledged that expiring land leases and the inability of the government to resolve this issue have contributed to the industry’s demise, in this paper we provide a fresh perspective on the problems in Fiji’s sugar industry. This paper aims to estimate a sugarcane production model for Fiji, delineating the short-run and long-run determinants with particular emphasis on the relationship between Fiji Sugar Corporation’s (FSC’s) profitability and sugar cane production. Amongst our key results we find that FSC’s profitability situation has had a statistically significant negative effect on sugar cane production, leading us to conclude that the FSC has been inefficient in the management the sugar mills, management of the rail transport system and sugarcane research which it is also responsible for managing.
Introduction

Sugar is Fiji’s oldest industry, being in the vanguard of economic growth and development for over a century. The literature to date has singled out expiring land leases and the inability of the government to resolve this issue as the key to the current calamity (see, for instance, Reddy and Yanagida 1998; Prasad and Tisdell 1996; Lal 2000; Lal et al. 2001; Reddy 2001; Kurer 2001). The impending erosion of the preferential prices have also been a cause for concern for farmers, hence reducing the keenness to continue to produce sugarcane in a sustainable manner. Despite the plethora of studies on Fiji’s sugar industry, there has been no empirical analysis of the relationship between sugarcane production in Fiji and the profitability situation of the Fiji Sugar Corporation. This is an important gap as the FSC is also responsible for providing advice through its extension services to farmers and managing the research on sugarcane to support the farmers. It is there vital that the relationship between FSC’s profitability and sugarcane production being studied. The present study aims to remedy this deficiency. The aim of this paper is to estimate a sugar cane production model, augmenting it with an ‘efficiency’ variable – FSC’s profitability – in order to gauge whether FSC has been efficient in its management and support of sugar cane production.

The rest of the paper is organised as follows. In the next section, we provide a brief overview of the Fiji sugar industry. This is followed by a description of the econometric model and econometric methodology adapted in this analysis. In the penultimate section we present the empirical results while the final section concludes with some policy implications.

An Overview of Sugar Industry in Fiji

There is a general consensus in the literature regarding the important role of the sugar industry in leading Fiji’s drive for economic success. Sugar production contributes about 7 per cent of gross domestic product (GDP) and generates 22 per cent of total exports. It accounts for 8.5 per cent of total foreign earnings and generates direct and indirect employment for about 51,000 people (Government of Fiji, 2002). The government in its strategic development plan for 2003-2005 has put forward a number of policy objectives. These include:

- the restructure of the sugar industry into a commercially viable and efficient industry;
- improving the milling efficiency and introduction of cane quality payment system; and
- improving the efficiency of sugarcane production, diversification of production into a range of sugar by-products and initiating long term reforms to make the sugar sector internationally competitive (Government of Fiji, 2002).

There are four sugar mills in the country, employing around 4,500 workers. In addition, there are 14,300-15,000 cane cutters and about 2,000 lorry operators. In all, about 25 percent of the economically active population derive their income from the industry. The labour force in the industry is made up of both family (household) and hired labour.

In a recent study, Narayan and Prasad (2003), using a computable general equilibrium model, show that if sugar productivity falls by 30 per cent, it will have a deleterious impact on Fiji’s economy. Their main results, which highlight the importance of the industry to Fiji’s economy, were as follows:
• real GDP will fall by 1.8 per cent;
• real national welfare will fall by 1.5 per cent;
• government savings will fall by 26.6 per cent;
• private disposable income will fall by 2.7 per cent; and
• real consumption will fall by 1.6 per cent.

In 1975, there were only 16,995 sugarcane farmers, while in 1998 their numbers had increased to 22,146 – a 30 percent increase - with an average farm holding of about 4.6 hectares. Area harvested increased from 44,000 hectares in 1975, reaching its peak in 1993 (75,000 hectares) before falling sharply to settle at 45,000 hectares in 2000. In the corresponding period the average sugarcane production per hectare increased from 49.1 tonnes/hectare to 59.2 tonnes/hectare in 1993, and settled at 32 tonnes/hectare in 2000 (Fiji Bureau of Statistics, 2002).

The performance of the industry is credited to the preferential agreements that Fiji has received since 1975. Fiji’s sugar industry has benefited immensely under the Sugar Protocol of the Lome Convention. Since 1975, a substantial amount of the sugar quota, which currently stands at 197,000 tonnes, has been offered. Fiji currently has a quota equivalent to 0.9 percent (14,000 tonnes) of the total United States sugar import quota, and bilateral agreement with Malaysia allows for the export of 90,000 tonnes of sugar per year’ (Lal et al. 2001, p. 3). The sugar price offered to Fiji under the Lome convention is 2-3 times above the world market price of sugar (Narayan 1999).

Around 85 to 90 percent of sugar production is exported, while the rest meets local consumption demand. The United Kingdom and the European Union are Fiji’s main sugar market – collectively accounting for around 45 per cent of total sugar exports, followed by Malaysia which buys 24 per cent of Fiji’s sugar while Japan purchases around 20 per cent. The rest of the sugar is sold to Singapore, South Korea, Canada, China and the United States.

Model specification and data

Following Narayan (2003), a Cobb-Douglas specification to sugar production in Fiji is adopted. We use the same data set, where proxies used for capital are: area harvested and fertiliser usage and proxy for labour force variable is the number of growers. He also models the impact of price paid to sugarcane farmers. We do not include this variable; instead, consistent with our aim, we include the profits of FSC as a variable to measure FSC’s efficiency It should be noted that given the small sample size and to avoid ‘spurious’ regression results we do not model the price paid to sugar cane farmers. In addition, we also include a dummy to capture the effect of the expiry of sugar cane land leases. Hence, the long-run model of sugar cane production takes the following form:

\[
SCP_t = \alpha_0 + \alpha_1 A H_t + \alpha_2 L A B_t + \alpha_3 F E R_t \\
+ \alpha_4 P R O F I T_t + \alpha_4 L E A S E_t + \epsilon_t
\]  

(1)
where \( \alpha_0 \) represents a constant; 
\( SCP_t \) represents sugarcane production (000 tonnes) at time \( t \); 
\( AH_t \) represents the area harvested (000 hectares) at time \( t \); 
\( LAB_t \) represents labour force at time \( t \); 
\( FER_t \) represents fertiliser usage at time \( t \); 
\( PROFIT_t \) represents FSC’s profits/loss; and 
\( \varepsilon \) represents the error term.

Area harvested, labour force and fertiliser usage are expected to contribute positively to sugarcane production so the \textit{a priori} expectation is that \( \alpha_1, \alpha_2 \) and \( \alpha_3 \) will be greater than zero. The expected sign on the profit variable is a priori ambiguous. If, for instance, it is positive it reflects the FSC’s efficiency in managing production; however, if it is negative then it reflects the FSC’s inefficiencies in managing production. Finally, we expect expiring of sugar cane land leases to negatively impact sugarcane production in Fiji. The model is estimated using annual data between 1972-2000. This period and frequency is chosen because it provides the most consistent data set available. All data are extracted from official publications such as the \textit{Current Economic Statistics}, published by the Fiji Bureau of Statistics, the \textit{Reserve Bank of Fiji Quarterly}, published by the Reserve Bank of Fiji, and the Fiji Sugar Corporation annual reports.

\textbf{Methodology: Johansen test for cointegration}

The concept of cointegration was pioneered by Granger (1981) and extended by Engle and Granger (1987). It is based on the premise that, as is common knowledge now, many economic times series are non-stationary. In spite of this, an appropriate linear combination between trending variables could remove the common trend component. The resulting linear combinations of the time series variables will thus be stationary, implying that the relevant time series variables are cointegrated. Evidence of cointegration rules out the possibility of the estimated relationship being ‘spurious’.

To estimate the cointegrating relationship between sugar cane production and its determinants, Johansen’s (1988, 1991) Full Information Maximum Likelihood (ML) technique is used. Given that it is possible to have multiple long-run equilibrium relationship between sugar cane production and its determinants, the technique described by Johansen (1988, 1991) and Johansen and Juselius (1990) allows one to determine the number of statistically significant long-run relationships between sugar cane production and its determinants. The Johansen approach to cointegration is based on Vector Autoregression (VAR). Consider the unrestricted VAR model represented by the following equation:

\[
Y_t = \alpha + \sum_{k=1}^{p} \Pi_k Y_{t-k} + \varepsilon_t, \quad t = 1,\ldots,T
\]

where \( \varepsilon_t \) is a i.i.d. \( p \)-dimensional Gaussian error with mean zero and variance matrix \( \Lambda \), 
\( Y_t \) is an \((n \times 1)\) vector of \( I(1) \) variables, and \( \alpha \) is an \((n \times 1)\) vector of constants. Given that \( Y_t \) is assumed to be non-stationary, specifying \( \Delta Y_t = Y_t - Y_{t-1} \), equation (1) can be expressed in error correction form as follows:
\[ \Delta Y_t = \sum_{k=1}^{p-1} \Gamma_k \Delta Y_{t-k} + \Pi Y_{t-1} + \varepsilon_t \]  
(3)

where \( \Delta Y_t \) is an \( I(0) \) vector, \( I \) is an \( (n \times n) \) identity matrix,

\[ \Gamma_k = \sum_{k=1}^{p-1} \Pi_k - I = -(I - \Pi_1 - \ldots - \Pi_k) \quad k = 1, 2, \ldots, p - 1, \]

and

\[ \Pi = \sum_{k=1}^{p} \Pi_k - I = -(I - \Pi_1 - \ldots - \Pi_p) \]

Johansen’s approach derives maximum likelihood estimates of the cointegrating vectors for an autoregressive process with independent errors. The \((n \times n)\) matrix \( \Pi \) can be written as the product of \( \theta \) and \( \beta \), two \((n \times r)\) matrices each of rank \( r \), such that \( \Pi = \beta \theta' \). The rank \( r \) of the long-run matrix determines how many linear combinations of \( Y_t \) are stationary. If \( r = 0 \) so that \( \Pi = 0 \), equation (3) translates into a first-differenced VAR model. For \( 0 < r < n \), there exist \( r \) cointegrating vectors – that is, \( r \) stationary linear combinations of \( Y_t \). The cointegrating vector \( \theta \) has the property that \( \theta' Y_t \) is stationary even though \( Y_t \) is non-stationary. In this light, Equation (3) can be rewritten as:

\[ \Delta Y_t = \alpha + \sum_{k=1}^{p-1} \Gamma_k \Delta Y_{t-k} + (\beta \theta') Y_{t-1} + \varepsilon_t \]  
(4)

Johansen (1988) and Johansen and Juselius (1990) have developed two tests for determining the number of cointegrating vectors: these are the likelihood ratio trace test and the maximum eigenvalue test. The likelihood ratio test (trace test) for the hypothesis that there are at most \( r \) cointegrating vectors is given by

\[ \lambda_{tr} = -T \sum_{i=q+1}^{p} \log \left( 1 - \hat{\lambda}_i \right) \]  
(5)

where \( T \) is the number of observations used for estimation, and \( \hat{\lambda}_i \) is the \( i \) th largest estimated eigenvalue. The null hypothesis is that the number of cointegrating vectors is less than or equal to \( r \), where \( r = 0, 1, 2, \ldots, \) etc.

On the other hand the maximum eigenvalue test is of the form

\[ \lambda_{max} = -T \log \left( 1 - \hat{\lambda}_r \right) \]  
(6)

for testing the null hypothesis of \( r - 1 \) cointegrating vectors against the alternative of \( r \) cointegrating vectors. Both tests have non-standard distributions and critical values are tabulated in Johansen and Juselius (1990: 208-9). Eviews version 4.0 also reports the critical values.
**Long-run relationship**

Having found a long-run relationship, we estimated Equation 1 using the following ARDL \((p,q,r,s,t)\) model:

\[
SCP_t = \alpha_0 + \sum_{i=1}^{p} \beta_i SCP_{t-i} + \sum_{i=0}^{q} \phi_i AH_{t-i} + \sum_{i=0}^{r} \gamma_i LAB_{t-i} \\
+ \sum_{i=0}^{s} \eta_i FER_{t-i} + \sum_{i=0}^{t} \sigma_i PROFIT_{t-i} + \mu_t
\]  

(7)

In estimating Equation, again a maximum of two lags is used, that is, \(i = 2\) and the model is selected using the Schwartz Bayesian criterion.

**Short-run relationship**

The Granger representation theorem states that in the presence of a cointegrating relationship among variables, a dynamic error correction representation of the data exists. Following Engle and Granger (1987) we estimated the following short-run model:

\[
\Delta SCP_t = \beta_0 + \sum_{q=0}^{m} \eta_q \Delta SCP_{t-q-1} + \sum_{q=0}^{m} \theta_q \Delta AH_{t-q} + \sum_{q=0}^{m} \zeta_q \Delta LAB_{t-q} \\
+ \sum_{q=0}^{m} \phi_q \Delta FER_{t-q} + \sum_{q=0}^{m} \phi_q \Delta PROFIT_{t-q} + \gamma_1 LEASE_t + \delta \varepsilon_{t-1} + \mu_t
\]  

(8)

All variables in Equation (8) were defined before. \(\mu_t\) is the disturbance term; \(\Delta\) is the first difference operator; \(\varepsilon_{t-1}\) is the error correction (one lagged error) generated from Johansen multivariate procedure (Sedgley and Smith 1996), and \(m\) is the lag length. By specification, Equation (8) lagged dependent and independent variables; a ‘test down’ procedure is employed repeatedly until the most parsimonious specification is achieved.

Equation (8) captures both the short and long run relationship between sugar cane production and its determinants. The long-run relationship is captured by the lagged value of the long-run error correction term, expected to be negative, reflecting how the system converges to the long-run equilibrium implied by Equation (1); convergence is assured when \(\delta_1\) is between zero and minus one.

**The Empirical Findings**

**Unit roots**

A necessary but not sufficient condition for cointegration is that all series should share the same unit root properties in a univariate sense. Hence, prior to testing for cointegration, we investigate the integrational properties of each of the variables by applying the Dickey and Fuller (DF, 1979, 1981) and the Phillips and Perron (PP, 1988) tests for unit roots. Table 1 presents the DF and PP tests for the five variables, sugar cane production, hectares harvested,
labour force, fertilizer usage and profits, in levels and in first difference. The DF statistic suggests that all variables are integrated of order one, $I(1)$. The PP test results, while different in their significance level, are supportive of the DF results in that the hypothesis that the time series contain an autoregressive unit root cannot be rejected for any of the variables in their level form. However, when all these variables are differenced once and subjected to the DF and PP tests, we find that the test statistics do not exceed the critical values. This leads us to the conclusion that all variables are stationary in their first differences.

**Table 1: Dickey Fuller (DF) and Phillips and Perron (PP) tests for unit roots**

<table>
<thead>
<tr>
<th>Variables</th>
<th>DF statistics [lag length]</th>
<th>PP statistics [Bandwidth]</th>
</tr>
</thead>
<tbody>
<tr>
<td>$SCP_t$</td>
<td>-2.7241 [0]</td>
<td>-2.6522 [1]</td>
</tr>
<tr>
<td>$\Delta SCP_t$</td>
<td>-8.8732 [0]</td>
<td>-8.8510 [1]</td>
</tr>
<tr>
<td>$AH_t$</td>
<td>-1.7975 [0]</td>
<td>-1.7614 [2]</td>
</tr>
<tr>
<td>$\Delta AH_t$</td>
<td>-7.1136 [0]</td>
<td>-6.8750 [3]</td>
</tr>
<tr>
<td>$FER_t$</td>
<td>-2.5588 [0]</td>
<td>-2.6612 [2]</td>
</tr>
<tr>
<td>$LAB_t$</td>
<td>-1.7443 [0]</td>
<td>-1.8331 [2]</td>
</tr>
<tr>
<td>$\Delta LAB_t$</td>
<td>-6.7737 [0]</td>
<td>-6.6473 [3]</td>
</tr>
<tr>
<td>$PROFIT_t$</td>
<td>-3.1109 [0]</td>
<td>-3.1946 [0]</td>
</tr>
<tr>
<td>$\Delta PROFIT_t$</td>
<td>-7.4196 [0]</td>
<td>-7.4924 [0]</td>
</tr>
</tbody>
</table>

Critical values

<table>
<thead>
<tr>
<th></th>
<th>Levels</th>
<th>First difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 per cent</td>
<td>-3.6702</td>
<td>-3.6793</td>
</tr>
<tr>
<td>5 per cent</td>
<td>-2.9640</td>
<td>-2.9677</td>
</tr>
<tr>
<td>10 percent</td>
<td>-2.6210</td>
<td>-2.6229</td>
</tr>
</tbody>
</table>

**Cointegration**

The results for the Johansen and Juselius cointegration test are presented in Table 2. The various hypotheses to be tested, from no cointegration i.e., $r = 0$ to a higher number of cointegration vectors, are reported in the first two columns of the table. The maximum eigenvalue and trace test statistics associated with the combination of $l(1)$ levels of the $Y_t$ vector are in the third column, with the statistics ordered from highest to lowest. Starting with the null hypothesis of no cointegration i.e., $r = 0$ among the variables, the maximum eigenvalue statistic is 61.22, which exceeds the 95 per cent critical value of 34.40. Moreover, the maximum eigenvalue statistic when $r = 1$ is also greater than the 95 per cent critical value, implying two cointegration relationships between sugar cane production and its determinants.

On the other hand, the trace test statistic (125.18) for the null hypothesis of no cointegration $r = 0$ exceeds the 95 per cent critical value of 75.98 and the statistic when $r = 1$ (63.96) is also greater than the 95 per cent critical value of 53.48. Thus, the results from the maximum eigenvalue corroborate the trace test and we conclude that there are two cointegration relationships between sugar cane production in Fiji and its determinants.
### Table 2: Johansen’s test for cointegration

Cointegration with restricted intercepts and no trends in the VAR  
Cointegration LR Test Based on **Maximal Eigenvalue** of the Stochastic Matrix

List of variables included in the cointegrating vector:
SCP  AH  LAB  FERT  PROFIT
Intercept
List of eigenvalues in descending order:

<p>| | | | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.87889</td>
<td>.75516</td>
<td>.30087</td>
<td>.25786</td>
</tr>
</tbody>
</table>

Null  Alternative  Statistic  95 per cent Critical Value  90 per cent Critical Value
r = 0  r = 1       61.2199     34.4000     31.7300
r <= 1 r = 2       40.8077     28.2700     25.8000
r <= 2 r = 3       10.3795     22.0400     19.8600
r <= 3 r = 4       8.6483      15.8700     13.8100
r <= 4 r = 5       4.1298      9.1600      7.5300

Use the above table to determine r (the number of cointegrating vectors).

Cointegration with restricted intercepts and no trends in the VAR  
Cointegration LR Test Based on **Trace** of the Stochastic Matrix

List of variables included in the cointegrating vector:
SCP  AH  LAB  FERT  PROFIT
Intercept
List of eigenvalues in descending order:

<p>| | | | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.87889</td>
<td>.75516</td>
<td>.30087</td>
<td>.25786</td>
</tr>
</tbody>
</table>

Null  Alternative  Statistic  95 per cent Critical Value  90 per cent Critical Value
r = 0  r >= 1      125.1852    75.9800     71.8100
r <= 1 r >= 2      63.9653    53.4800     49.9500
r <= 2 r >= 3      23.1576    34.8700     31.9300
r <= 3 r >= 4      12.7781    20.1800     17.8800
r <= 4 r = 5       4.1298     9.1600      7.5300

Use the above table to determine r (the number of cointegrating vectors).

Cointegration with restricted intercepts and no trends in the VAR  
Choice of the Number of Cointegrating Relations Using Model Selection Criteria

List of variables included in the cointegrating vector:
SCP  AH  LAB  FERT  PROFIT
Intercept
List of eigenvalues in descending order:

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.87889</td>
<td>.75516</td>
<td>.30087</td>
<td>.25786</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>Maximized LL</th>
<th>AIC</th>
<th>SBC</th>
<th>HQC</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0</td>
<td>-808.4240</td>
<td>-833.4240</td>
<td>-850.5125</td>
<td>-838.7767</td>
</tr>
<tr>
<td>r = 1</td>
<td>-777.8140</td>
<td>-812.8140</td>
<td>-836.7417</td>
<td>-820.3079</td>
</tr>
<tr>
<td>r = 2</td>
<td>-757.4102</td>
<td>-800.4102</td>
<td>-829.8071</td>
<td>-809.6169</td>
</tr>
<tr>
<td>r = 3</td>
<td>-752.2204</td>
<td>-801.2204</td>
<td>-834.7192</td>
<td>-811.7118</td>
</tr>
<tr>
<td>r = 4</td>
<td>-747.8963</td>
<td>-800.8963</td>
<td>-837.1296</td>
<td>-812.2441</td>
</tr>
<tr>
<td>r = 5</td>
<td>-745.8314</td>
<td>-800.8314</td>
<td>-838.4320</td>
<td>-812.6074</td>
</tr>
</tbody>
</table>

AIC = Akaike Information Criterion  
SBC = Schwarz Bayesian Criterion  
HQC = Hannan-Quinn Criterion
**Long-run elasticities**

The long-run elasticities are presented in Table 3. Beginning with the variable of most interest to us in this study – FSC’s profit situation – we find that it appears with a negative sign, implying that as FSC profit increased over the sample period it has a negative impact on sugar cane production in Fiji. This result reflects the fact that FSC has been inefficient in managing sugar cane production related activities such as extension services to farmers and research. There has always been a concern amongst farmers about the FSC’s lack of investment in the rail transport system which also became inefficient over the last two decades. The FSC also undertakes to supply farmers with essential food items such as rice and sugar. According to the Sugar Cane Growers Council, these aspects have also been inefficiently handled. On could also conclude that FSC’s profit in the last decade may have been due to its lack of spending on the infrastructure that supported the farmers and indeed production of sugarcane.

Area harvested has the largest effect on sugarcane production. This finding has direct implications for the current land problems in Fiji. Since 1997 sugarcane land leases have been expiring at a rapid rate. The bulk of the land, whose leases have expired, remains unused and is occupied by bushland. This points to a situation of declining usage of land for sugarcane production. Put differently the area harvested has fallen – from 73,000 hectares in 1997 to 45,000 hectares in 2000. In the corresponding period sugarcane production fell from 3,280 thousand tonnes to 1,900 thousand tonnes (Fiji Bureau of Statistics, 2001). The empirical evidence supports this.

Fertiliser usage also appeared with a positive sign – implying the fact that fertilizer usage is an important input in the production process. Our result on the labour force variable, however, is statistically insignificant.

| Table 3: Long-run results of the determinants of sugarcane production in Fiji, 1970-2000 |
|-------------------------------------------|-------------------------------------------|
| **Variable**                             | **Parameter estimate**                     | **t-statistics**                     |
| Constant                                 | -1122.2**                                  | -2.2571                              |
| $AH_t$                                    | 60.5658***                                 | 7.2059                               |
| $LAB_t$                                   | 0.0137                                     | 0.3652                               |
| $FER_t$                                   | 0.6217**                                   | 2.2638                               |
| $PROFIT_t$                                | -22.7172**                                 | 2.2571                               |

Note:  *** significance at the 1 per cent level  
** significance at the 5 per cent level

Next we look at the short-run results. Again, as in the long run, we find that FSC’s profits have had a negative impact on sugar cane production (Table 4). Another important, and obvious result, is with respect to our dummy variable used to capture the effect of expiring sugar cane land leases. As expected, expiring land leases have had a negative impact on sugar cane production in Fiji. This result is statistically significant at the 5 per cent level of significance.
Table 4: ECM results of the determinants of sugarcane production in Fiji

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>t-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-1653.5**</td>
<td>-2.0982</td>
</tr>
<tr>
<td>ΔSCP_{t-1}</td>
<td>0.3414**</td>
<td>2.2783</td>
</tr>
<tr>
<td>ΔAH</td>
<td>89.2371***</td>
<td>6.0307</td>
</tr>
<tr>
<td>ΔLAB_{t}</td>
<td>0.0202</td>
<td>0.3600</td>
</tr>
<tr>
<td>ΔFER_{t}</td>
<td>0.9161**</td>
<td>2.2938</td>
</tr>
<tr>
<td>ΔPROFIT_{t}</td>
<td>-33.4713**</td>
<td>-2.3817</td>
</tr>
<tr>
<td>LEASE_{t}</td>
<td>-494.6687</td>
<td>-2.0026</td>
</tr>
<tr>
<td>$EC_{t-1}$</td>
<td>-1.4734***</td>
<td>-7.5258</td>
</tr>
</tbody>
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Notes: *** significance at the 1 per cent level
** significance at the 5 per cent level.

The result on the importance of area harvested in determining sugarcane production is, like in the long-run, statistically significant. This result is in corroboration with the impact of the dummy variable capturing the expiring land leases. The importance of area harvested clearly reflects the negative effects of expiring land leases and the subsequent non-use of land on sugarcane production in the short-run. On the other hand, as in the long-run, labour force is statistically insignificant in explaining sugarcane production. Lastly, we find that fertilizer usage, like in the long-run, is a statistically significant determinant of sugar cane production.

The error correction term $EC_{t-1}$, which measures the speed of adjustment to restore equilibrium in the dynamic model, appeared with a negative sign and was statistically significant at the 1 per cent level ensuring that the series is non-explosive and that long-run equilibrium can be attained. Apart from the high significance levels of variables and the existence of a long-run relationship, our model is statistically well behaved. We applied a number of diagnostic tests to the error correction model (Table 5). There is no evidence of autocorrelation in the disturbance of the error term. The ARCH tests suggest that the errors are homoskedastic and independent of the regressors. The model passes the Jarque-Bera normality test suggesting that the errors are normally distributed. The RESET test indicates that the model is correctly specified, while the F-forecast test indicates the predictive power/accuracy of the model. In addition, the adjusted R-squared of the model is high implying an excellent fit of the model – 80 per cent of the variations in sugarcane production is explained by the regressors.
Table 5: Diagnostic tests

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<tr>
<th>Diagnostics</th>
<th>Statistics</th>
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<tr>
<td>$R^2$</td>
<td>0.8658</td>
</tr>
<tr>
<td>$\bar{R}^2$</td>
<td>0.8211</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.0785</td>
</tr>
<tr>
<td>$\chi^2_{Auto}(1)$</td>
<td>0.2383</td>
</tr>
<tr>
<td>$\chi^2_{Norm}(2)$</td>
<td>0.0791</td>
</tr>
<tr>
<td>$\chi^2_{White}(1)$</td>
<td>2.4152</td>
</tr>
<tr>
<td>$\chi^2_{RESET}(1)$</td>
<td>0.1801</td>
</tr>
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Where $\sigma$ is the standard error of the regression; $\chi^2_{Auto}(1)$ is the Breusch-Godfrey LM test for autocorrelation; $\chi^2_{Norm}(2)$ is the Jarque-Bera normality test; $\chi^2_{RESET}(1)$ is the Ramsey test for omitted variables/nonlinear form; and $\chi^2_{White}(1)$ is the White test for heteroscedasticity.

Critical values for $\chi^2(2) = 5.99$ and $\chi^2(1) = 3.99$.

Lastly, the stability of the regression coefficients is evaluated using the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) of the recursive residual test for structural stability (Brown et al., 1975). The regression equation appears stable given that neither the CUSUM nor the CUSUMSQ test statistics exceed the bounds of the 5 per cent level of significance (Figures 1 and 2).
Figure 1: CUSUM test for stability
Figure 2: CUSUM squares test for stability

CUSUM of Squares  5% Significance
In this paper we estimated a sugarcane production model for Fiji covering the period 1970-2000. In so doing this paper has made a significant contribution in not only explaining the determinants of sugarcane production in Fiji but also unravelling the link between sugar cane production and FSC’s profitability situation – our measure of FSC’s efficiency.

We find two important sets of results. First, econometric findings reveal that area harvested and expiry of land leases have a strong and statistically significant impact on sugarcane production. This result supports calls for urgent solutions to the issue of expiring sugar cane land leases in Fiji.

Second, we find that in both the short-run and long-run FSC’s profitability has contributed negatively to sugar cane production in Fiji. On the basis of this result we conclude that FSC has been inefficient in its management of sugar cane production.

Our results have some important implications for the restructure of the sugar industry in Fiji. While all stakeholders in the sugar industry including the government recognise the need for restructuring yet there is no agreement at present on a way forward. The sugar industry as a whole involves the processes of cane production, transportation, milling and marketing. In the past, there has been a tendency for the FSC and government to blame the farmers for the ills of the industry. Those who blame the farmers for the ills of the industry must realise that sugarcane production component has never been a serious problem as farmers with small holdings continued to produce sugarcane that was more than enough to satisfy the quota for the European Union market. There is no doubt that there are many inefficient farmers. For example, out of the 21,371 registered farmers, there are about 4,000 ‘non-performing’ farmers who produce less than 10 tonnes of cane and these farmers will eventually fall out from the industry. In fact, it is likely that more farmers would move out of cane production if there were alternative crop farming available to them. This is going to leave the industry with a group of fairly productive farmers in the industry.

The real issue in the restructure therefore is the milling component of the industry. There is no doubt that to a large extent, the industry’s problems could be attributed to the years of inefficiency in the milling and transportation system due to poor management by the FSC.

FSC like, a typical government enterprise continued to disregard the inefficiency concerns in the mills and deliberately apportioned the blame on external factors such as the Master Award. For example, when Japan rejected the sugar shipment on the grounds of poor quality, FSC and government blamed the farmers for burning the cane. In this respect the problem is not burnt cane, but the inability of the FSC over so many years to develop the rail system so that cane could be quickly delivered to the mills for processing hence preserving the quality of sugar produced. In Brazil, most of the cane supplied to the mills is burnt cane, yet the quality of sugar is still very high because the transport system is very efficient and cane is supplied to the mills within 36 hours.

While FSC has made some recent investments it has been misdirected and inefficient. For example, in the last 15 years the FSC invested about $300 million dollars, that is, $20 million dollars a year. More recently at the Lautoka Mill, $10 million dollars was spent on a new mill to improve efficiency. However, it is reported that the old mill was crushing 45,000 tonnes per week while the new mill crushes only about 30,000 tonnes a week, a decline of about 15,000 tonnes. This is a very good example of mismanagement in terms of capital
investment to improve milling efficiency, yet the government has continued to bail out FSC through transferring the sugar tax income.

For the purpose of the restructure the original proposal where the role of the government will be minimal and where the landowners, growers and workers will play a major role as shareholders in the Stand Alone Companies (SACs) might be an appropriate one.

This may also be an appropriate opportunity for the government and the Native Lands Trust Board (NLTB) to develop an integrated programme to help indigenous Fijian farmers undertake sugarcane farming. The NLTB and the government should not be ‘hung up’ with the NLTA versus ALTA debate instead they should work rapidly towards renewing leases to existing productive farmers as well as new farmers under ALTA. As our results, the availability of land is a critical factor determining whether sugarcane production will continue. Since 1997 the amount of land undercane has declined and if the land leases are no longer available in a secure form then production could decline further. The fact, that 48 percent of the leases between 1997-2002 have been renewed under ALTA implies that land leases could be resolved within the ALTA legislation. Despite all the criticisms labeled at ALTA, NLTB and indeed indigenous Fijian farmers who take on new leases may ultimately find the ALTA legislation very useful in the long-run. These decisions could help remove some of the uncertainties surrounding land leases.
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<th>Author(s)</th>
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